JSC-09080

NASA TECHNICAL MEMORANDUM

NASA TM X-58138
August 1974

# A BRIEF DESCRIPTION OF THE MEDICAL INFORMATION COMPUTER SYSTEM (MEDICS)



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LYNDON B. JOHNSON SPACE CENTER

HOUSTON, TEXAS 77058

| 1. Report No. TM X-58138 | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| 4. Title and Subtitle<br>A BRIEF DESCRIPTION OF THE MEDICAL INFORMATION COMPUTER SYSTEM (MEDICS) | | 5. Report Date<br>August 1974<br>6. Performing Organization Code<br>JSC-09080 |
| 7. Author(s)<br>Edward C. Moseley | | 8. Performing Organization Report No.<br>951-17-00-00-72<br>10. Work Unit No. |
| 9. Performing Organization Name and Address<br>Lyndon B. Johnson Space Center<br>Houston, Texas 77058 | | 11. Contract or Grant No.<br>13. Type of Report and Period Covered<br>Technical Memorandum |
| 12. Sponsoring Agency Name and Address<br>National Aeronautics and Space Administration<br>Washington, D.C. 20546 | | 14. Sponsoring Agency Code |
| 15. Supplementary Notes | | |

16. Abstract

The Medical Information Computer System (MEDICS) is a time-shared, disk-oriented minicomputer system capable of meeting storage and retrieval needs for the space- or non-space-related applications of at least 16 simultaneous users. At the various commercially available low-cost terminals, the simple command and control mechanism and the generalized communication activity of the system permit multiple form inputs, real-time updating, and instantaneous retrieval capability with a full range of options.

17. Key Words (Suggested by Author(s))
'Data Retrieval
'Data Storage
'Management Information System
'Time Sharing
'Minicomputers
'Real-time Operation

18. Distribution Statement

| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 23 | |

CONTENTS

## FIGURES

# A BRIEF DESCRIPTION OF THE MEDICAL INFORMATION COMPUTER SYSTEM (MEDICS)

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## SUMMARY

The Medical Information Computer System (MEDICS), developed by the Life Sciences and Data Systems and Analysis Directorates at the NASA Lyndon B. Johnson Space Center for use in space- and non-space-related applications, is a time-shared, disk-oriented minicomputer system capable of meeting the diverse storage and retrieval needs of at least 16 simultaneous users by means of remotely located commercially available terminals. In addition to providing cost effectiveness, the system provides a simple command and control mechanism, generalized communication activity, and timeliness in information handling. The generalized storage and retrieval portion of the system permits multiple inputs of different forms, real-time updating from terminals, and a full range of retrieval options.

## INTRODUCTION

For several years, the Life Sciences Directorate (LSD)[1] at the NASA Lyndon B. Johnson Space Center (JSC) has been developing a low-cost multiuser minicomputer system to meet a variety of space-related operational needs. The system is flexible, easy to learn and use, relatively inexpensive, and capable of producing instantaneous results for as many as 16 users at one time. The system, the Medical Information Computer System (MEDICS), can also be used in applications other than the space program; for example, the usefulness of MEDICS in supporting a health care delivery program is currently being evaluated in a cooperative Department of Health, Education, and Welfare (HEW)/NASA program.

This report, a brief review of the major features of the developed minicomputer system, should provide general information for management purposes and should give the individual reader sufficient information to decide if the

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[1]Technical direction in design, implementation, and operations has been provided by Government personnel in the Data Systems and Analysis Directorate.

system will or will not be generally useful for his application. Complete technical information can be obtained from JSC on request, and programs will be provided at cost by the JSC Technology Utilization Office.

## SYSTEMS PHILOSOPHY AND MAJOR FEATURES

Although the specific MEDICS system is a recent development, the basic ideas have been being developed and refined for almost 10 years (table I of the appendix). The consistent intent has been to develop a general-purpose record system that is relatively independent of the method or equipment used in records management. The resulting major features of MEDICS are discussed in the following paragraphs.

### Generalized Storage and Retrieval Capability

The storage and retrieval system is basically designed for handling forms. The user defines and describes to the system as many blank forms as are appropriate to his needs. The definition of each form includes the title chosen by the user, the identification, the organizational headings and subheadings, and the name and units chosen for each item or variable. The system then stores the user's blank form, sets aside memory space for the future storing of many forms to be completed as information becomes available, displays a blank form at any remote terminal, and stores the completed forms upon remote demand. Thus, the user's data base is a collection of completed forms with titles, headings, structure, and contents of his own definition. An important secondary gain of this forms philosophy is that a naive user, a new employee, or a manager can browse through the blank forms to determine what information is or is not being collected.

Retrieval of information is basically a sorting and matching process. The user specifies what information or subinformation he wants from his form or forms, what processing he wants to do, and how he wants the results displayed. Results are then displayed remotely. A simplified example of this storage and retrieval process is shown in figure 1.

### Communication Control and Integration Within an Organization

Communication to and from the system is accomplished over normal telephone lines on any combination of dedicated or "dial up" lines (fig. 2). Thus, all or some subsets of information entered at one remote terminal can be called for at any other terminal. Because one can retrieve all or subsets of information from different forms, the system is an excellent tool for integration of reports. Any user can obtain information on his report that was developed by one or more other users. This type of organization is available for real-time space-flight monitoring and has proved invaluable for interdependent subsystems.

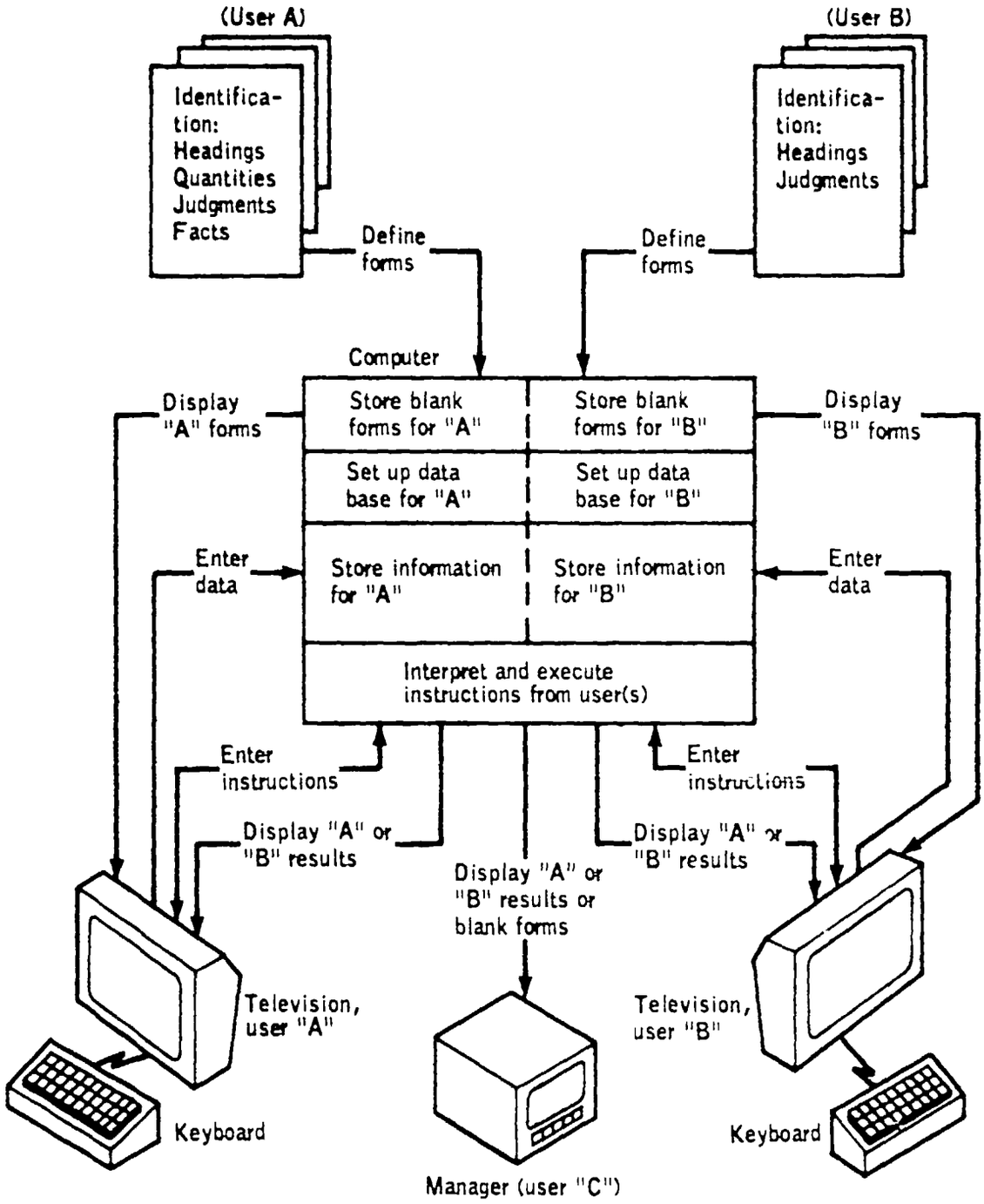


Figure 1.- The basic process of the MEDICS multiple-user storage and retrieval system. The user defines his forms to the system and completes each form as information becomes available. At any time, the user can request a search for specific information, tabulation, or statistical reports on his data base. If authorized, user C can browse forms and obtain any information in the system. Sixteen users can simultaneously and independently operate/use the system.

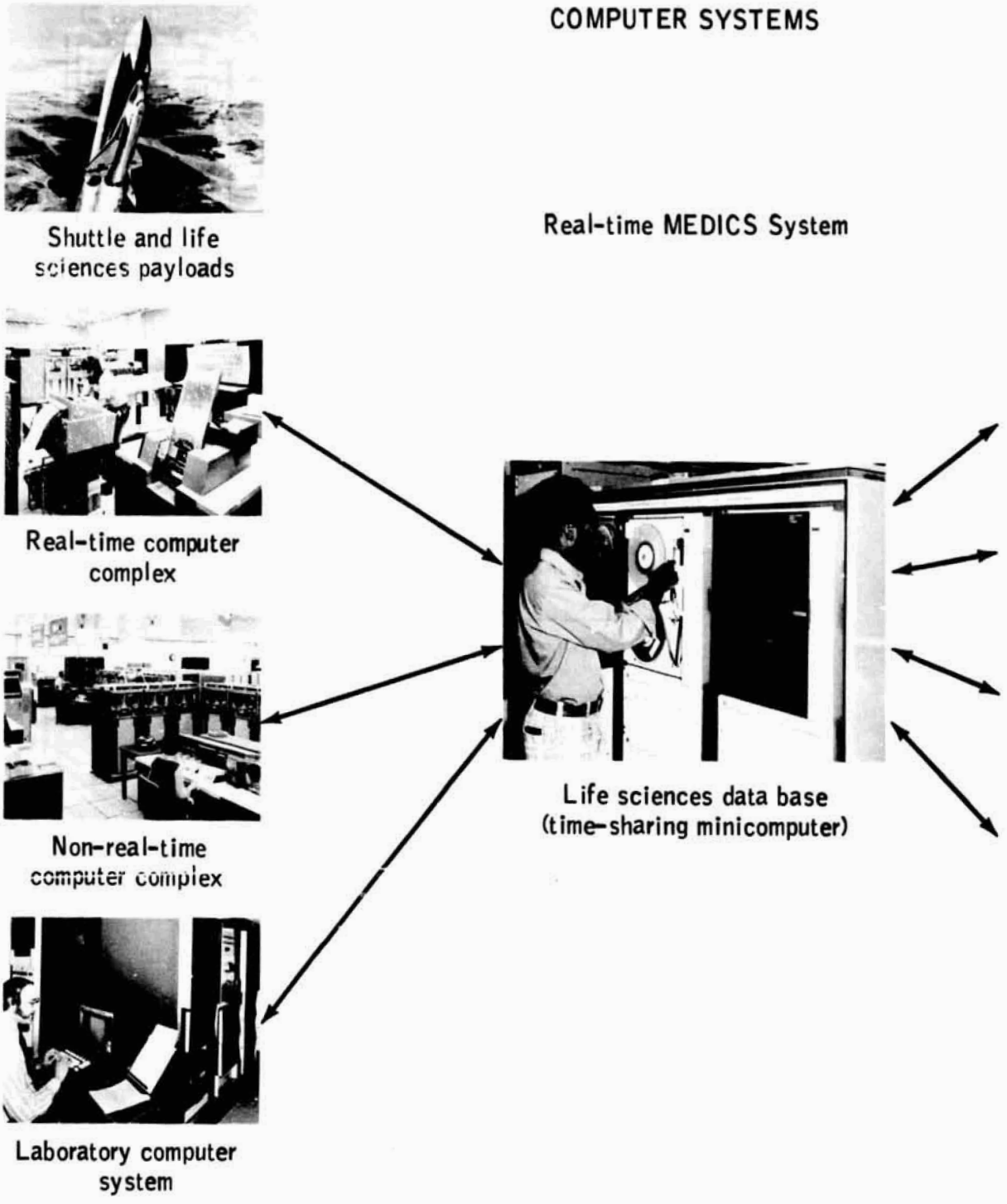


Figure 2.- Functional real-time support provided by MEDICS. Sixteen separate remote terminals and four directly connected independent computers can use the system simultaneously. The types of jobs worked at each terminal are given in table II.

## REMOTE TERMINALS

Medical staff support room

Flight Medicine Branch

Occupational medicine


Preventive medicine (surveillance)

Microbiological laboratory

Skylab time and motion study

Physician/system interface research and development

Archival record index

Dispensary

Dispensary

Dispensary

Dispensary

Shuttle food program

Management review terminal

Training terminal

Shuttle testing

Figure 2.- Concluded.

### Multiple Real-Time Interactive Terminals

Users communicate with the MEDICS through a variety of commercially available terminals. Low-cost television displays, electric typewriter terminals with hardcopy provisions, and combinations of these are commercially available for purchase or rental; these terminals are connected to the system by standard telephone connections. Thus, any information stored in the system is simultaneously available for as many as 16 users at any time and at any place where there is a dial-up telephone line. Figure 2 shows the 16 remote terminals; the functions of each terminal are listed in table II of the appendix.

### Simple Command and Control Mechanisms

Before any system can be responsive, it must know what the user wants. Many interactive systems respond as if the user is new no matter how many times he has used the system. The design philosophy and the implementation of MEDICS have eliminated or minimized this problem. In addition to simplifying user/system interaction in retrieving information, considerable effort was also expended to provide simple but effective control mechanisms to facilitate data entry and to ensure data base security, accuracy, and completeness.

### Direct Connection to Larger and Smaller Computer Systems

The Life Sciences Directorate, like many hospitals, has a number of laboratories doing research and development work as well as generating data that are useful for operational purposes (e.g., the blood laboratory). Many of these laboratories have their own minicomputers dedicated to handling laboratory activities. However, there are classes of problems (e.g., iterative calculations) that can be done most efficiently on large computers. Efforts are underway to connect the MEDICS directly with several of these other systems (fig. 1).

## MEDICS DESCRIPTION

### Hardware

A block diagram of the current minicomputer system configuration (including expansions planned during 1974) is given in figure 3. As indicated in figure 3, the minicomputer is a Varian 73, currently operating with 32K of core memory and a 29-million-byte removable disk. The total purchase price of the system, excluding terminals, was $111 000. The 16 MEDICS-supported remote terminals located throughout JSC were typically purchased on an as-needed basis at prices varying from $500 to $3500. Terminals may be rented for a monthly fee ranging from $60 to $180. The terminal user does not need to know about the computer hardware to use the system.

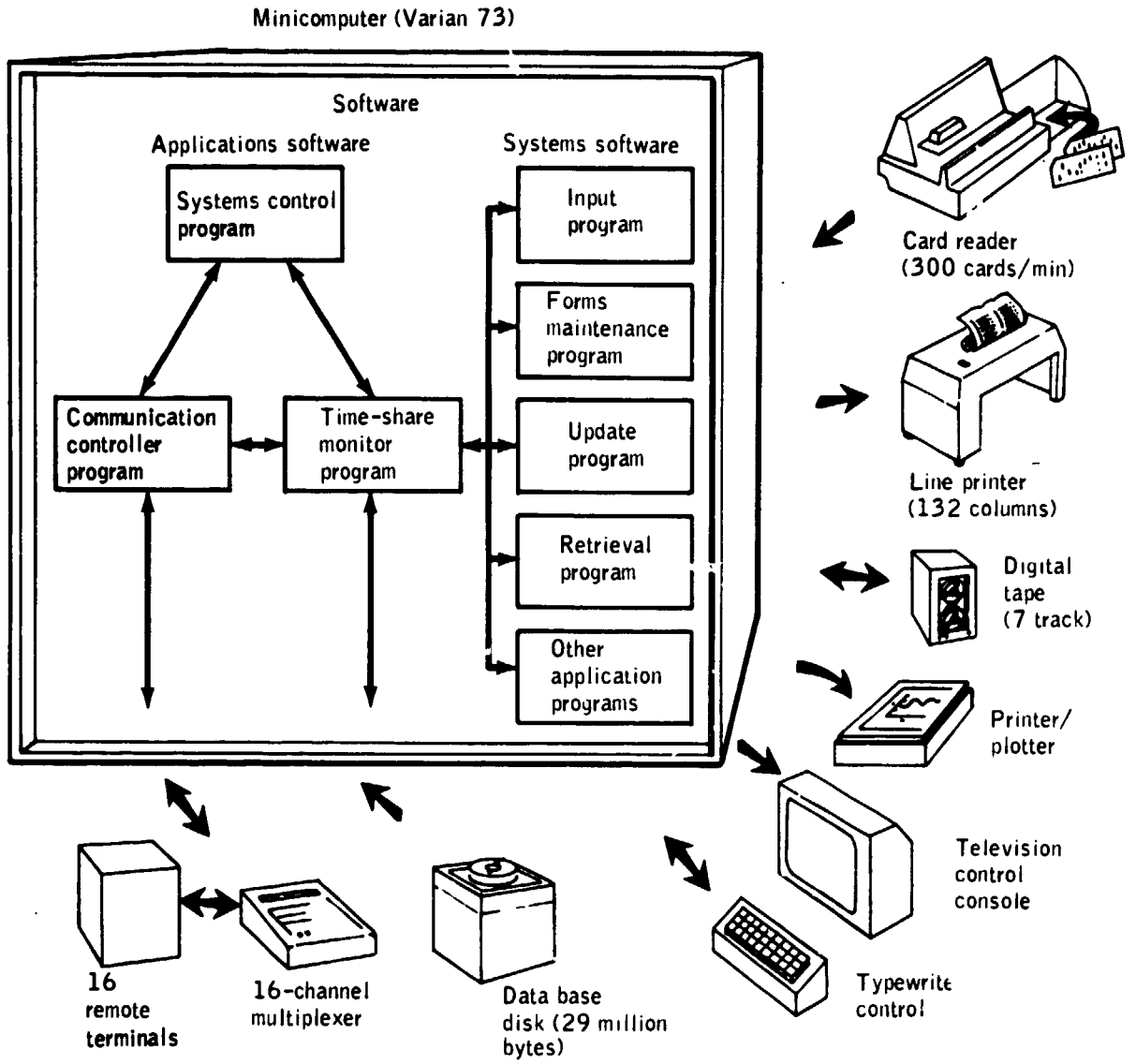


Figure 3.- The current MEDICS hardware and software configuration. The total cost of the systems hardware, excluding terminals, was $111 000. Terminal purchase prices ranged from $500 to $3500 each; terminals can be rented for $60 to $180 per month. Software modules, or computer programs, are called in and out by the time-share monitor program. The operation of each program is discussed in the text.

## Computer Programs

Software modules, or computer programs that instruct the computer operation, have been developed to aid in the operation of the system (systems software) and to aid users in obtaining the results they need from the system (application software). Both types of software are shown in figure 3; the latter is described more extensively in table III of the appendix.

The systems software consists of an operating system provided by the manufacturer, a NASA-developed communication module to handle all terminal requests, and a NASA-developed time-share monitor to allow multiple simultaneous users. The time-share module transfers application programs to and from the disk as required. This transfer is done so fast that each terminal user thinks he is the only one using the minicomputer system. The typical response time on all terminals ranges from less than a second to several seconds.

Application software relevant to the MEDICS storage and retrieval process consists of the following five modules.

1. Forms maintenance program, used to set up a data base, to generate and update the data collection forms, and to handle any changes to the collection forms.

2. Input program, used to enter data into the data base, to assist in editing data being entered, and to aid the user in speeding up his entry of data (by using prestored messages or omitting certain items, etc.).

3. Update program, used to add, delete, or change information once it is stored on the disk.

4. Retrieval program, used to find the selected information from a data base, to reorganize and perform the mathematical operations required, and to display the results to the remote user. The retrieval program provides for selective listing, tabulating, and cross-tabulating of functions with or without descriptive statistics. Other special features of this program permit setting restrictions on the search (e.g., limiting answers to those within a given range), precoded stored retrieval requests, and index listing of the information available in a given data base. Table III lists other currently available features; the user's guide gives information on how to use them.

5. Other application programs, used to develop other specific programs and to store them on the disk to be run in real time when the user calls for them.

## Types of Users

As indicated in table II, the separate terminals accommodate the purposes of a number of concurrent users. The important point to be noted is the variety of functions and the multiplicity of forms that can be handled by the MEDICS. Any information stored on data bases can be physically obtained at

the remote terminals; however, a security system has been implemented to prevent an unauthorized retrieval from another user's data base. If a terminal user does not properly identify himself by a periodically changed, six-character, random-access, alphanumeric code, the computer ignores his request.

Because the program is dynamic, some terminals and their unique data bases will be eliminated as projects are completed. Long-range users will occasionally want to revise their forms; provisions exist with the MEDICS to handle form revisions.

## RURAL HEALTH CARE DELIVERY EVALUATION

In cooperation with the HEW, NASA is developing a remote health care delivery program called STARPAHC.[2] In addition to advanced communication systems, medical instrumentation, and a mobile health unit, the data subsystem will consist of a minicomputer virtually identical to that shown in figure 3 (including the hardware improvements). Installation is scheduled for 1974 and will be followed by a 2-year program of field operation and evaluation.

Software for this health care program includes the MEDICS programs previously noted, new application programs appropriate to the health care providers, and direct real-time connection to an existing Indian Health Service (IHS) computer system (ref. 1). The types of reports and outputs available at different remote terminals are shown in figure 4. Additional software refinements developed by and for JSC will be added to this remote health care system for field testing as appropriate.

## FUTURE PLANS FOR MEDICS

One of the advantages of a minicomputer is its flexibility for modular growth, which allows the user to get started and do useful work while waiting for additional funding to become available for additional functions. The present system was purposely restricted to limited memory so that non-NASA applications could start with relatively expensive software capable of operating within low-cost hardware. This phase has now been completed and documented (refs. 2 to 7), and useful work is being performed at the Center.

An expanded version of MEDICS is currently underway that will provide 74K of core memory and 60 million words of disk storage. This expansion will increase the total hardware cost from $110 000 to $150 000. These hardware improvements will permit more real-time data bases, increase the number of terminals, and decrease terminal response time.

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[2] Space Technology Applied to Rural Papago Advanced Health Care.

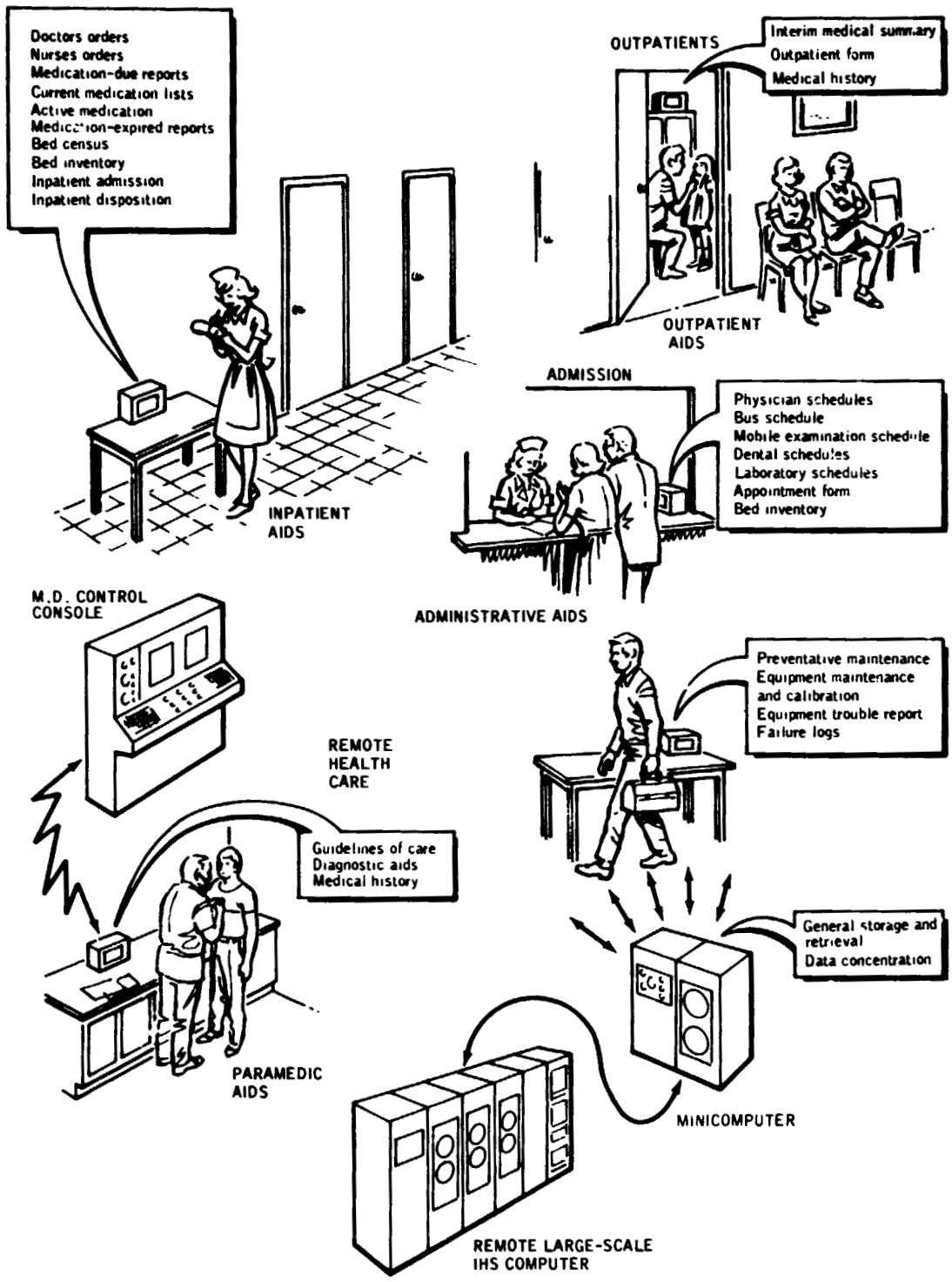


Figure 4.- Pictorial representation of data system used in the NASA/HEW health care delivery program for Papago Indians. The callouts indicate the types of reports available at the terminals. Numerous other reports are available from the remote large-scale Indian Health Service (IHS) system.

Future software is expected to focus on adding application programs useful to the life sciences areas in their institutional, experimental, and operational space-flight programs. The general nature of these expansions is shown in table IV of the appendix. Although these expansions will be developed to meet the needs of the Lyndon B. Johnson Space Center, they will be described in their general form so that non-NASA-related activities can benefit from the work.

Lyndon B. Johnson Space Center
National Aeronautics and Space Administration
Houston, Texas, July 15, 1974
951-17-00-00-72

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# APPENDIX

## SUPPLEMENTAL DESCRIPTIVE INFORMATION ON THE MEDICAL INFORMATION COMPUTER SYSTEM (MEDICS)

TABLE I.- DEVELOPMENTAL HISTORY OF GENERAL-PURPOSE RECORD SYSTEM

| Group | Date | Prime development | Computer name | Computer class |
|---|---|---|---|---|
| Tulane University Medical School | 1964 | Conceptual schema and demonstration systems | IBM 1401 | |
| M. D. Anderson Hospital (Tate M. Minkler, M.D.) | 1965 | Batch system for astronaut records | IBM 360-45 | Large scale |
| Lyndon B. Johnson Space Center (Lockheed Electronics) | 1967 | Batch system for astronaut records, laboratory records, surveillance records | Univac 1108 | Large scale |
| Lyndon B. Johnson Space Center (Philco-Ford) | 1970 | Single-user real-time tape retrieval system | Varian 620f | Minicomputer |
| Denver Presbyterian Medical Center (Tate M. Minkler, M.D.) | 1970 | Commercial time-shared medical information management system | Control Data Corporation (CDC) 6500 | Large scale |
| Goddard Space Flight Center (Occupational Safety and Health Administration) | 1971 | Commercial time-shared medical information management system for industrial safety, legal documentation | CDC 6500 | Large scale |
| Lyndon B. Johnson Space Center (Philco-Ford) | 1973 | Time-shared disk-oriented minicomputer storage and retrieval system (MEDICS) | Varian 73 | Minicomputer |
| Lyndon B. Johnson Space Center (Lockheed Missiles and Space Co.) | 1974 | Time-shared disk-oriented minicomputer storage and retrieval system with added data concentration and "tie in" with central system | Varian 73<br>IBM 370-145 | Minicomputer<br>Large scale |

TABLE II.- TERMINAL AND COMPUTER INTERFACE FUNCTIONS

(a) Terminal functions

| Terminal | Terminal function |
|---|---|
| Medical staff support room | Provides flight surgeon with real-time selective retrieval capability of crewman's medical and examination history during flight |
| Flight Medicine Branch | Enters and selectively retrieves all crewmens' examination, flight, and test results |
| Occupational medicine | Enters and selectively retrieves special occupational medicine analysis for all NASA Centers, produces statistical reports for Department of Labor, and selectively retrieves examination criteria by occupation and industrial environment |
| Preventive medicine (surveillance) | For employees in contact with crew, enters medical examination results and family health status, updates daily, reports medical changes, and produces preventive medicine statistics |
| Microbiological laboratory | Enters test results, searches data base to identify micro-organisms, and collates results with the Dispensary and Flight Medicine data bases |
| Skylab time and motion study | Enters coded activity and time and motion from Skylab film; selectively searches, tabulates, and compares equivalent activity segments |
| Physician/system interface research and development | Develops simplified and functionally comprehensive input/output hardware to be evaluated by MEDICS |
| Archival record index | Enters descriptive information on all Skylab operational and experiment data, including stored location; provides complete browsing capability and selective retrieval for all missions |

TABLE II.- TERMINAL AND COMPUTER INTERFACE FUNCTIONS - Concluded

| Terminal | Terminal function |
|---|---|
| JSC Dispensary (multiple terminals) | Enters and selectively retrieves JSC employees' physical examination results; updates examinations, edits inputs, and collates data from other laboratories; provides cumulative medical history for each employee; produces disease statistic reports and studies; assists in scheduling and appointment notification |
| Flight food | Enters flight food requirements and manufacturing and quality control information; provides selective retrievals indicating food program status |
| Management review | Retrieves status reports from all medical and bioengineering systems; provides browsing capability to verify life sciences program operational readiness |
| Training | Reviews MEDICS training manual; generates temporary data bases; provides experience in using all MEDICS functions |
| Medical equipment (Shuttle) | Enters milestones on all flight medical equipment; updates and edits; provides engineering status on demand |

(b) Computer interface functions

| Computer interface | Computer interface function |
|---|---|
| Laboratory computer | Inputs, updates, and retrieves body fluid variables measured on crews and employees; provides physiological data summaries on crewmen and from the executive physical exercise program; selectively collates for Dispensary and Flight Medicine data bases |
| Real-time computer complex | Supports flights by providing preflight and postflight life sciences information |
| Non-real-time computer complex | Supports life sciences experiments analysis by organizing data for input to larger system and accepting output from larger system |

TABLE III.- MEDICS REAL-TIME APPLICATION SOFTWARE CURRENTLY AVAILABLE

| Program designation | Functional description |
|---|---|
| A. Retrieval module | Retrieves user-selected data and displays it in desired form. |
| 1. "List" functions | A set of programs that lists (for any specified data base) the names of all forms, any selected "blank" form, identification information only, and all or selected portions of "answers" entered on complete or incomplete forms. |
| 2. "Tabulate" functions | A set of programs that reorganizes any selected answers, displaying them in a tabular or columnar form; also counts the number of answers meeting or not meeting some selection criterion, obtaining and displaying cross-tabular frequencies of any two selected variables. |
| 3. "Selection" functions | A set of programs that restricts searches; allows user to specify a range (e.g., dates) for a search, select specific multiple answers, and use Boolean (AND, OR, NOT) expressions (e.g., men and women not divorced or over age 40). |
| 4. "Macro" functions | A set of programs that allows the user to use predefined searches that are stored and assigned an arbitrary number; the search is then executed by use of only the number. Macros may be added, deleted, or modified from any terminal; further, a list of all macros may be obtained at any terminal in case the user forgets the associated name and number. |
| 5. "Statistics" functions | A set of real-time programs that provides simple statistics on any stored numeric data; both descriptive statistics (e.g., percentages of total, means, standard deviations, least-squares fits) and inferential statistics (e.g., chi-square, t-test between groups, correlation between any two user-selected variables) are available. |
| 6. "Plot" functions | A set of programs that allows the user to select any numeric variable and have it plotted; a "quick look" plot program will generate low-resolution plots at the user's low-cost remote terminal; high-resolution plots are produced on the printer/plotter attached to the system. |
| B. Input program module | Uses real-time programs to enter records into a data base. |
| 1. "Control" functions | Allows user to insert a "canned" or predefined common answer, to skip entering some incomplete items, or to abort storing a form. |
| 2. "Edit" functions | Allows user to edit or change an answer at the time error is made or at the end of a page. |

TABLE III.- MEDICS REAL-TIME APPLICATION SOFTWARE CURRENTLY AVAILABLE - Concluded

| Program designation | Functional description |
|---|---|
| 3. "Input statistics" functions | Provides count of total number of forms entered and number of incomplete forms entered. |
| 4. "Menu" input functions | Allows user to have precoded choices displayed (e.g., 1 = male, 2 = female); selected number causes system to input prose as opposed to user typing prose. |
| C. Update program module | Uses real-time programs to add, delete, or change data on the data base. |
| 1. "Modify specific answer" function | Provides real-time capability to add, change, or delete a specific answer, a range of answers, or multiple answers. |
| 2. "Modify entire form" function | Provides capability to remove either a used or unused form, or to move the form to a different data base. |
| 3. "Purge" function | Allows user to eliminate multiple cases from the data base simultaneously. |
| D. Forms maintenance module | Generates a form according to user's specification, establishes data base, and displays form on remote terminal. |
| 1. "Off-line forms creation" functions | Generates a particular form and sets up a particular data base by means of punched cards: to generate the particular form, the user specifies data base name, form name, each line in the form, the type of answer (e.g., prose, numeric, heading, comment), the name of the variable, units, numeric limits, and precoded information. |
| 2. "Terminal forms creation" functions | Generates forms as for off-line forms creation but permits user to accomplish generation and revisions through remote terminals. |
| E. Systems operation module | Uses a set of programs to aid systems operations in controlling the system. |
| 1. "System statistics" functions | Provides management with performance and usage systems statistics (e.g., number of terminals in use). |
| 2. "Data base maintenance" functions | Periodically run program that reorganizes data base to obtain optimum retrieval time. |
| 3. "Systems recovery" functions | Program to "save" data in event of systems failure and to reduce system restart time. |
| F. Remote program development module | Uses several standard generalized programs that permit remote users to write their own programs. |

TABLE IV.- ADDITIONAL APPLICATION AND SYSTEMS SOFTWARE PLANNED FOR EXPANDED VERSION OF MEDICS

| Title | Function |
|---|---|
| Interactive control | Generates developer-selected stimuli (e.g., questions) and developer-selected branches dependent on a user's response; can be used to implement automated history taking, controlled care procedures, diagnostic aids, etc. |
| Message switching | Provides remote-terminal user with capability to select sources for user-generated messages or reports |
| Scheduling | Provides remote-terminal users with capability to generate and track schedules |
| Program evaluation and review technique (PERT) | Provides remote-terminal users with capability to identify and track manufacturing processes |
| Graphics handling | Provides remote-terminal users with capability to store, input, and output graphics notes |
| Computer output microfilm | Provides capability to produce microfilm from the system |
| Computer-to-computer interfaces | Supplies hardware and software required to connect Varian 73 to IBM 370-145, Varian 620f, Control Data Corporation (Cyber 70), and Univac 1108 computers |

☆ U.S. GOVERNMENT PRINTING OFFICE: 1974—671-193/455